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Product Improvement to Incorporate a Fluid Immersed Ball Rotor S & A Device in M550 40mm Dual Purpose Grenade Fuze

Breed Corp.

November 1975

CONTRACT DAAA21-75-C-0158

PRODUCT IMPROVEMENT TO INCORPORATE A FLUID IMMERSED BALL ROTOR S & A DEVICE IN THE M550 40MM DUAL PURPOSE GRENADE FUZE

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FINAL REPORT FOR PERIOD JANUARY 8, 1975

thru OCTOBER 20, 1975

DEPARTMENT OF THE ARMY
Picatinny Arsenal
Dover, New Jersey 07801

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This is the third in a series of contracts to apply the teachings of a ball rotor computer program to various projectiles. Contract DAAA21-73-C-0650 and follow-on Contract DAAA21-74-C-0481 demonstrated that ball rotor fuze design constructed according to the teachings of a Breed Corporation ball rotor computer program could meet current arming distance criteria for

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INTRODUCTION

Following several years of inhouse analytical effort, a computer program was evolved at Breed Corporation which was capable of analyzing the dynamics of a ball rotor fuze. Based on the results of running this computer program, Breed became convinced that it could design ball rotor fuzes for use in all spinning munitions assuring a predictable arming distance within the range desired for each munition. After limited test firings had tended to verify the computer predictions, an unsolicited proposal was submitted to Picatinny Arsenal to provide additional experimental data to further verify the computer program and to prove the feasibility of using the simple ball rotor as a replacement for more complicated gear train escapements and unwinding ribbon fuzes. Contract DAAA21-73-C-0650 and follow-on Contract DAAA21-74-C-0481 resulted from this unsolicited proposal. These contracts under the technical guidance of Picatinny Arsenal used fluid immersed ball rotor S & A devices and substantiate the success of the computer modeling of ball rotor inertial delays. These contracts indicated that ball rotor S & A devices could be used to provide arming delays for all spinning projectiles. In particular, preliminary test results on 20MM, 40MM and 57MM projectiles indicated feasibility of achieving the desired arming distance characteristics for these rounds.

This is the final report on a third contract, the objective of which was to produce and test a significant quantity of ball rotor S & A devices for use with the low velocity 40MM projectile as a lower cost replacement for Fuze PD M550.

The ball rotor is one of the simplest of all known arming delay mechanisms. It is also one of the oldest fuzing mechanisms having been invented supposedly in the late nineteenth century. Throughout the years, it has been used to provide arming delays for many spinning munitions from 20MM up to the largest artillery shells. Its performance has generally been discouraging, however, both in terms of the minimum arming distance and the dispersion of arming distances. Ball rotor fuzes have traditionally armed too close to the gun to provide for a safe separation distance and others have armed at such a great distance as to increase the incidents of duds. As a result, the ball rotor has generally been replaced by more expensive fuzing mechanisms. Practically the only high volume fuze which still uses the ball rotor mechanism is the 20MM M505A3. Even in this application it does not provide the minimum arming distance desired.

After several years of inhouse effort at the Breed Corporation, a mathematical model of the ball rotor fuze was constructed at Breed which for the first time was able to explain how the ball rotor worked and what was required to improve its performance.

THE COMPUTER PROGRAM

A discussion of the original 3 degree of freedom ball rotor analysis appears in the final report of Contract DAAA21-73-C-0650. This program has since been extended to include translation of the ball in addition to rotation. Both programs have been utilized extensively in analyzing the low velocity 40MM ball rotor fuze during this contract.

Perhaps a review of the significant results of the ball rotor analysis is in order. After several years of extensive analysis coupled with live test firings, a clear understanding of ball rotor characteristics now exists. Very briefly, the distance required for the ball rotor to arm is a function of the friction forces between the ball rotor and its housing. If there were no friction forces, the ball rotor would never align. If the ball contacts the housing at a point through which a transverse moment of inertia passes, the ball rotor will align within a few feet of the muzzle of the gun. Conversely, if the contact point is rotated 90 degrees about the projectile axis, once again the ball rotor will never align. All other cases lie somewhere between these extreme points. Typically, a ball rotor will move around the housing contacting it at many points which give rise to friction torques which in a complex fashion permit gradual alignment of the detonator axis with the spin axis. The friction forces between the ball and the housing and in particular, the locus of the contact points between the ball and the housing during the arming cycle control the arming distance. In addition, the relationship between the polar and transverse moments of inertia of the ball rotor is critical. If these moments of inertia are close together, friction forces between the ball and housing can easily create rolling contact between the ball and the housing. On the other hand, if the polar and transverse moments are far apart, the ball will slide on the housing and its motion will be more dependent on the angular momentum of the ball rotor. For a given friction torque, therefore, the ball rotor with a larger difference between these moments of inertia will have its behavior less dominated by friction forces and thus will result in a more consistant arming distance.

The locus of the contact points has an obvious effect on the alignment of the ball rotor. In the extreme cases mentioned above, the arming distance went from practically zero to infinity by a simple movement of 90 degrees of the contact pivot point. This is perhaps the most significant result which has escaped researchers to date. This location of the contact point is primarily determined by the eccentricity in the flight of the projectile. Since the eccentricity generally gets larger with larger projectiles, this is why the ball rotor has not functioned well in projectiles much larger than 20MM. The 20MM results, however, have been much better. To use a ball rotor in larger projectiles, therefore, the effect of shell eccentricity must be significantly reduced. The first step of course would be to reduce to a minimum the friction coefficient between the ball and housing since all of the friction torques on the ball contain the coefficient of friction as a factor. The second step would be to use fluid buoyant forces to reduce the effective mass of the ball rotor since this also is a factor in all of the friction torques. A third approach is to utilize some method of eliminating within the fuze some or all of the shell eccentricity. Thus a mechanism is required which will move the ball rotor and its housing relative to the fuze toward the projectile spin axis. This, it is believed, can be effectively done through the use of a dense fluid, a plastic ring, and a ball rotor. During spin of the projectile, buoyant forces in the dense fluid will move the plastic ring which acts as the housing for a ball rotor, toward the spin axis of the projectile. It was the investigation of this concept which was a key element to be undertaken in this contractual effort and which is reported on in this final report.

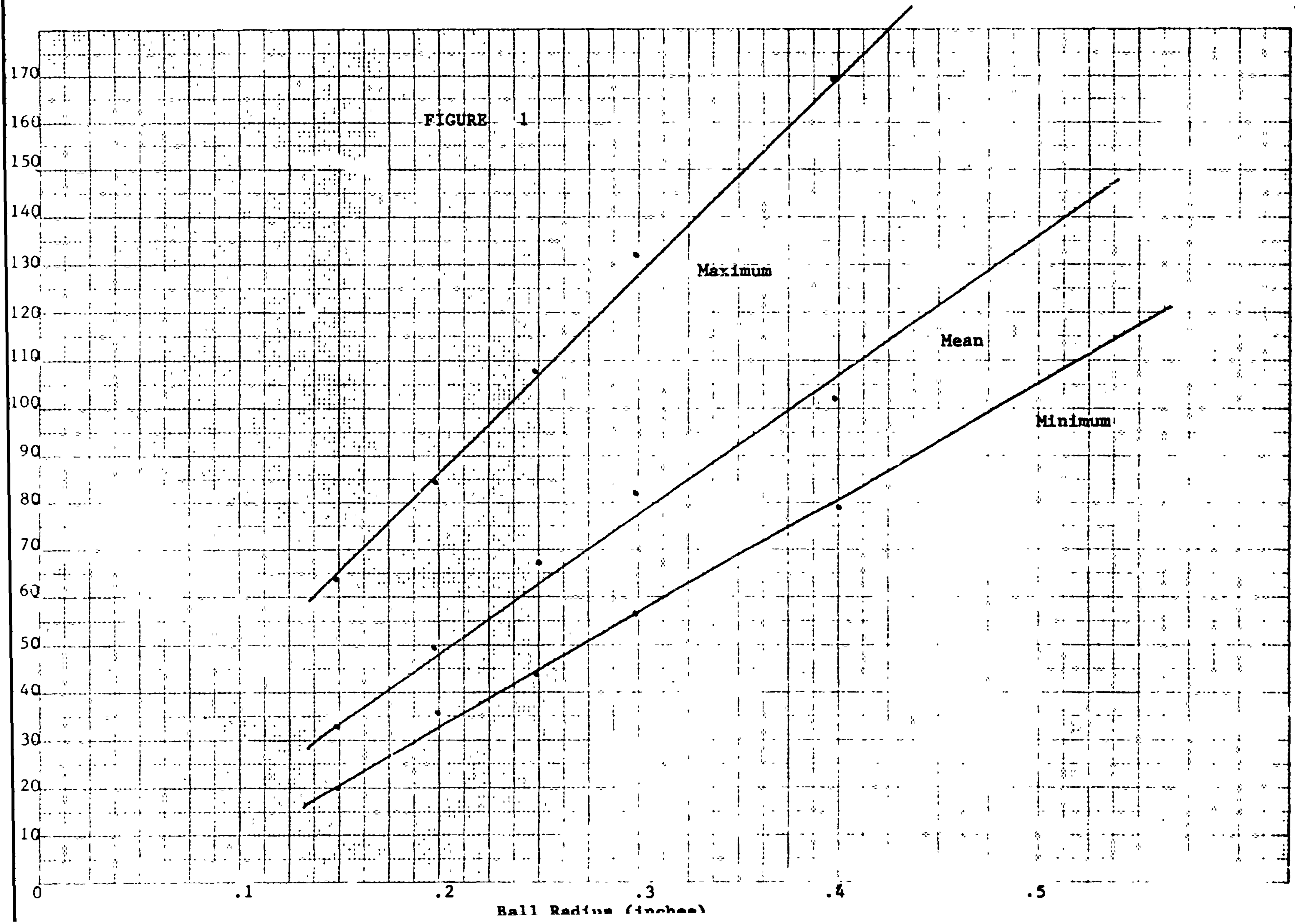
TEST RESULTS - ARMING DISTANCE

The test results relating to arming distance are discussed here chronologically. The actual test results can be found in Appendix I. The first test firing consisted of two rounds, one fired at 200' and one at 300'. Both were du . which led to the suspicion that the upward motion during setback of the plastic centering ring was being resisted by the fluid. Two inert fuzes were fired as test #2, one was lost, the second recovered and found to have functioned. Eight and ten fuzes containing the modified centering ring were fired as tests #3 and #4 to give an indication of the arming distance. A statistical analysis of these test firings indicated a minimum arming distance of a little below 45 feet. This was consistent with the computer analysis to date.

Twelve rounds were fired for test #5. Two were fired at 90', both of which went high order, the remaining ten were fired at 45' with only one functioning. Since this agreed with the previous test results, an effort was undertaken to increase the minimum arming distance above 45'. The first approach involved an attempt to change the ratio of the transverse to the polar moment of inertia. The analysis indicated that if a plastic sleeve could be placed around the detonators for the full length of the ball rotor, a significant improvement in the moment of inertia ratio would be achieved. In practice, however, due to the presence of the lock ring grooves, a much smaller plastic sleeve was all that could be used. The results of test #6 of ten rounds contained this modification and showed no significant improvement from the previous test results. A second attempt to increase the mean arming distance resulted from an extensive computer analysis to determine the effect of ball size on the arming distance. The results of this analysis are summarized in Figure 1. From these results, one would expect an approximate 20% increase in the arming distance if the ball rotor diameter were increased from 3/8" to 7/16". Ten units were constructed and fired as test #7, which indicated that the 20% arming distance increase had in fact been achieved.

In an attempt to determine the minimum arming distance, twenty fuzes were initially assembled for test #8. Three were fired at 90', all of which were duds. The test was discontinued and sixteen units were centrifuged tested at Breed Corporation, all of which armed. Since these test results were inconsistent with all previous results, all of the parts were reworked to improve surface finishes and other minor characteristics. They were reassembled and two rounds were fired at 90' as test #9,

FIGURE 1


Maximum
Mean
Minimum
170
160
150
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130
120
110
100
90
80
70
60
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40
30
20
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0
.1
.2
.3
.4
.5
Ball Radius (inches)

both of which were again duds. These were retrieved, x-rayed and disassembled at Picatinny Arsenal where it was determined that everything had functioned properly, however, in one case the ball rotor was 10 degrees out of alignment and in the other case 70 degrees. In spite of these results, there was some concern that perhaps the target material was not thick enough to initiate the round, therefore, two additional rounds were fired through a double thickness target at 70', both of which were duds. The rounds were retrieved and disassembled wherein it was learned that the ball rotors were 30 and 40 degrees out of alignment, respectively.

The next suspicion lay in the design of the lock ring grooves. Six rounds were constructed for test #11, three having the standard lock ring grooves and three having substantially smaller grooves. It was felt that perhaps the grooves were upsetting the moment of inertia ratio and effecting the dynamics of the ball. The ball rotor computer program at that time could only take into account one of the lock ring grooves. The six rounds were fired at 90' as test #11 with identical results. Two went and one was a dud in each. The grooves for both groups had been carefully made to assure that they were symmetrical. An examination of earlier ball rotors indicated that the upper groove had been at one end of the tolerance range, whereas the lower groove had been at the other, thus giving an imbalance to the ball rotor. The improved results tended to lend credence to the groove hypothesis. The two that were duds were 30 and 40 degrees out of alignment, respectively.

Three rounds were assembled for test #12 to see if perhaps the larger ball had merely moved the maximum arming distance out to a greater distance. Two were fired at 125 feet, one was a dud and the second went high order.

The examination of the dud in test #12 suggested that perhaps the lock ring would not release the ball if the projectile were highly eccentric. The ring was thus modified on three rounds and on three of the rounds a flat was milled on the top of the ball to place the center of gravity of the ball below the geometric center. All six were fired at 90' with one dud which was the round that did not have the flat on the ball. After these encouraging results, eleven units were assembled for test #14. The test was discontinued after the first dud at 90'. Four duds in total occurred which were disassembled. For the first time it was found that three of the four ball rotors were in fact lining up backwards.

Although the cause for the backward alignment was not discovered until near the end of the program, it might have been evident at this point. The first time backward alignment had been witnessed was after the spin weight had been modified to permit an earlier release of the ball rotor, thus, although this was not verified until later, by releasing the ball rotor early and then moving the centering mass to the spin axis, the ball under the influence of set back forces, would tend to roll along the bottom of the housing. All that is required is approximately .027 inches of motion in the right direction to roll the ball sufficiently to place the detonator axis at 90 degrees with respect to the projectile axis.

The results of test #14 made it imperative to return to the computer analysis and a modified program to contain the effect of the second lock ring groove. This analysis indicated the surprising result that the ratio of the moments of inertia of the ball rotor was not good. Through an oversight, the ball rotor detonator diameter had not been changed when the ball rotor was increased. The analysis of the effect of ball rotor diameter on arming distance was based on the assumption that the detonator would increase proportionally to the ball rotor diameter. All future ball rotors, therefore, were constructed placing an aluminum sleeve around the detonators, thus effectively increasing the size of the detonator. The computer analysis indicated an arming distance range for reasonable values of eccentricity of from 60 to 85 feet.

Ten units were constructed using the modified ball rotors for test #15, however, the second one fired was a dud at 90' and the test was discontinued. Disassembly of this unit again indicated that the ball rotor had lined up backwards.

Eight fuzes were assembled for test #16, with the initial angle placed at 70 degrees as opposed to 80 degrees. Although this was not realized at the time, this would require a motion of .365" to move the detonator axis to the 90 degree point. Since the maximum motion of the centering ring was .080", it is unlikely that this could occur. The test results of test #16 indicated all eight units functioned, however, one of the units went at 45' which had been considered too close to the gun.

At this time, the rolling ball theory was hypothesized and the body was modified to hold the centering ring on center prior to firing. Thus, the maximum motion of the centering ring would be reduced from .08" to .04". Five units went high order at 90 feet as test #17. Twelve additional units were assembled for test #18, nine of which were no go at 45 feet and three of which went high order at 90 feet. All of the no go rounds were returned and disassembled and all were found to be between 5 and 30 degrees from alignment. None were aligning backwards.

Twenty-one units were then assembled for test #19 to determine an arming distribution. These results indicated an arming distance range of from 50 to 90 feet.

Although test #20 and #21 were primarily graze tests, one out of six in each test was a dud and when disassembled was found with the ball rotor lined up backwards. Once again, the fuze was extensively analyzed using the computer program which indicated that the conditions were not favorable for the ball to line up backwards due to friction forces or ball dynamics. The only logical answer, therefore, was the rolling ball hypothesis discussed earlier. In test #23, a flat was placed on the bottom of the ball in an attempt to prevent it from rolling on the housing. Nevertheless, one out of eleven rounds did not function and when disassembled was found with the rotor backwards.

Once again, the detent spin weights were further modified to prevent any interference with the ball rotor. Ten inert fuzes were assembled and fired for recovery. Six units were found to have lined up correctly and four were backwards in test #24. In test #25, a ring was inserted around the centering ring to prevent the centering ring from moving. Ten units were fired, recovered and disassembled, all of which lined up properly, thus conclusively proving the rolling ball hypothesis.

Finally, ten units were reassembled for live firing with the same centering ring configuration as test #26. Two of the units armed at 45 feet indicating that the centering ring is necessary in order to extend the arming distance.

TEST RESULTS - GRAZE

Graze test results consisted of several firings with modification to the ogive, firing pin, ball rotor, explosive train and housing to increase the sensitivity of the round to graze impacts.

Along with test #3, one round was fired for graze with a standard ogive to see if it would crush. It was fired inert at 200 feet, recovered and was found not to have crushed, therefore a more sensitive ogive was designed. Three rounds were fired containing the new ogive as part of test #7. All three again would not have functioned. It was difficult to analyze the results of inert graze rounds due to subsequent impacts. Since Picatinny Arsenal personnel at first declined to fire live graze rounds, an air gun was designed and constructed at the Breed Corporation to simulate graze firing. Initial tests from the air gun, however, resulted in the air gun piston being destroyed with each firing since the piston must be stopped at the air gun muzzle, otherwise it would hit the slanted graze target before the ogive. At this time, Picatinny indicated that perhaps live firings could be undertaken providing a hard target was placed behind the graze target. Further work on the air gun was therefore suspended.

Several static tests were conducted with and without fluid at the Breed Corporation to simulate the gap that would be present in a graze round. It had been decided that to increase the sensitivity impacting the firing pin on graze impacts, the ball rotor should be permitted to move forward.- This, of course, would increase the gap which the detonator must jump to reach the booster. All of the simulated static test firings at the Breed Corporation were successful. One round was assembled with a maximum gap and fired into a target at 90 feet. This unit functioned low order. This was probably due to the displacement of the detonator from the projectile axis due to the action of the centering ring. The fact that the round went low order was not considered particularly harmful since the detonators used were considerably smaller than the ones which would be used in the production design.

Six units were assembled to create the maximum gap between the ball rotor and the thin section of the body above the explosive lead. Bench tests with this configuration had been successful. These six rounds were fired into a plywood target at 120 feet to check propagation as test #20. Two rounds went low order and one did not go, which as reported earlier was due to backward ball alignment. In test #21, provision was made to permit the ball to move forward on graze, impinging the detonator on the firing pin. Three rounds went high order when fired for graze. Two did not go on graze, but functioned on the cage behind the graze area, and one as previously mentioned, lined up backwards.

In test #22, modifications to the fuze included the removal of one cubic centimeter of fluid and the use of a more sensitive firing pin design. The first unit missed target and went high order on the cage, the second hit a barrel 55' in front of the gun and did not function. Three out of the remaining four functioned properly with the dud being due to backward ball rotor alignment. Thus, all of the fuzes which hit the target properly functioned high order with the exception of one where the ball reverse armed.

CONCLUSIONS AND RECOMMENDATIONS

This contract explored a new concept in ball rotor fuzing, the use of a centering system to substantially reduce the effects of shell eccentricity. It has been found that shell eccentricity is the most significant factor causing erratic ball rotor behavior. Although the concept of the centering system is simple, reverse arming problems were encountered which were not expected. The cause of the reverse arming problem eluded company and government engineers until near the end of the contract. Now that its cause is thoroughly understood to be due to the rolling of the ball on the housing as the centering ring moves toward the spin axis, the solution to the problem is near at hand.

Several approaches exist for eliminating this reverse arming problem. The first approach would be to place a shoulder on the top of the housing so that during setback the centering ring would be prevented from moving toward the spin center until after setback has ceased. Once setback has ceased, there will no longer be a force between the ball and the bottom of the housing, thus it should move onto the spin axis without rolling. Although this is the most promising approach, several other designs exist for eliminating this problem.

Although the graze tests results are limited in number due to the concentration of effort on the reverse arming problem, the final test results are encouraging. It is conceivable, but not expected, that propagation problems might appear when firing graze tests at high and low temperatures. This is an area which should be explored. Detonators used in the program so far are considerably smaller than those which should be used in the production design to overcome low order detonators.

It is strongly recommended that additional contractual effort be undertaken as a minimum to permit a few more firings to confirm the analysis discussed herein and a test firing of three hundred (300) rounds for statistically signifiant tests.

APPENDIX i

Round #	Distance	Go/No Go
1	200 feet	No Go
2	300 feet	No Go

TEST #1

MODIFIED CENTERING RING - NO DETENT WEIGHTS

Round #	Distance	Go/No Go
1	300 feet	Go
2	300 feet	Lost

TEST #2

MODIFIED RING

Round #	Distance	Go/No Go
1	300 feet	GO
2	300 feet	GO
3	50 feet	No Go
4	75 feet	GO
5	65 feet	No Go
6	75 feet	Go
7	65 feet	GO
8	55 feet	No Go

TEST #3

MODIFIED RING

Round #	Distance	Go/No Go
1	60 feet	Go
2	55 feet	No Go
3	60 feet	No Go
4	65 feet	Go
5	60 feet	Go
6	55 feet	No Go
7	60 feet	No Go
8	65 feet	Go
9	60 feet	Go
10	55 feet	Go

TEST #4

Round #	Distance	Go/No Go
1	90 feet	Go
2	90 feet	Go
3	45 feet	No Go
4	45 feet	No Go
5	45 feet	No Go
6	45 feet	No Go
7	45 feet	Go
8	45 feet	No Go
9	45 feet	No Go
10	45 feet	No Go
11	45 feet	No Go
12	45 feet	No Go

TEST #5

NEW PLASTIC SLEEVE AROUND DETONATOR

Round #	Distance	Go/No Go
1	60 feet	Go
2	65 feet	Go
3	55 feet	No Go
4	60 feet	Go
5	55 feet	Go
6	50 feet	No Go
7	55 feet	No Go
8	60 feet	Go
9	55 feet	No Go
10	60 feet	No Go

TEST #6

INWARD BALL DIAMETER

Round #	Distance	Go/No Go
1	65 feet	Go
2	60 feet	No Go
3	65 feet	No Go
4	70 feet	Go
5	65 feet	Go
6	60 feet	No Go
7	65 feet	No Go
8	70 feet	Go
9	65 feet	No Go
10	70 feet	Go

TEST #7

Round #	Distance	Go/No Go
1	90 feet	No Go
2	90 feet	No Go
3	90 feet	No Gc

TEST #8A

CENTRIFUGE TEST

Round #	Spinup Rate	R.P.M.	Go/No Go
1	slow	3600+	Go
2	slow	3600+	Go
3	slow	3200	Go
4	slow	3600+	Go
5	slow	24-3000	Go
6	slow	2600	Go
7	slow	2200	Go
8	slow	26-3600+	Go
9	slow	2200	Go
10	slow	2800	Go
11	slow	2800	Go
12	slow	2700	Go
13	fast	2200	Go
14	fast	2400	Go
15	fast	3000	Go
16	fast	2200	Go

TEST #8B

PARTS REWORKED

Round #	Distance	Go/No Go
1	90 feet	No Go
2	90 feet	No Go

TEST #9

CENTRIFUGE TEST

Round #	Spinup Rate	R.P.M.	Go/No Go
1	slow	3600+	Go
2	slow	3600+	Go
3	slow	3200	Go
4	slow	3600+	Go
5	slow	24-3000	Go
6	slow	2600	Go
7	slow	2200	Go
8	slow	26-3600+	Go
9	slow	2200	Go
10	slow	2800	Go
11	slow	2800	Go
12	slow	2700	Go
13	fast	2200	Go
14	fast	2400	Go
15	fast	3000	Go
16	fast	2200	Go

TEST #8B

THICKER TARGET

Round #	Distance	Go/No Go
1	70 feet	No Go
2	70 feet	No Go

TEST #10

Round #	Type	Distance	Go/No Go
1	1	90 feet	Go
2	1	90 feet	No Go
3	1	90 feet	Go
4	2	90 feet	Go
5	2	90 feet	Go
6	2	90 feet	No Go

Type #1: Standard Lock Ring Grooves

Type #2: Smaller Lock Ring Grooves

TEST #11

Round #	Distance	Go/No Go
1	125 feet	No Go
2	125 feet	Go

TEST #12

MODIFIED LOCK RING

Round #	Type	Distance	Go/No Go
1	1	90 feet	Go
2	1	90 feet	No Go
3	1	90 feet	Go
4	2	90 feet	Go
5	2	90 feet	Go
6	2	90 feet	Go

Type #1: Modified Lock Ring

Type #2: Modified Lock Ring and flat on top of ball

TEST #13

MODIFIED LOCK RING AND FLAT ON TOP OF BALL

Round #	Distance	Go/No Go
1	90 feet	Go
2	90 feet	Go
3	45 feet	No Go
4	45 feet	No Go
5	70 feet	No Go
6	90 feet	Go
7	90 feet	No Go

TEST #14

ALUMINUM DETONATOR SLEEVE ADDED

Round #	Distance	Go/No Go
1	90 feet	Go
2	90 feet	No Go

TEST #15

70^{o} STARTING ANGLE

Round #	Distance	Go/No Go	Comment
1	90 feet	Go	Low order
2	90 feet	Go	Low order
3	90 feet	Go	High order
4	90 feet	Go	High order
5	90 feet	Go	High Order
6	45 feet	Go	High order
7	90 feet	Go	Low order
8	90 feet	Go	High order

TEST #16

CENTERING RING CENTERED BEFORE FIRING

Round #	Distance	Go/No Go
1	90 feet	Go
2	90 feet	Go
3	90 feet	Go
4	90 feet	Go
5	90 feet	Go

TEST #17

Round #	Distance	Go/No Go
1	45 feet	No Go
2	45 feet	No Go
3	45 feet	NoGo
4	45 feet	No Go
5	45 feet	No Go
6	45 feet	No Go
7	45 feet	No Go
8	45 feet	No Go
9	45 feet	No Go
10	90 feet	Go
11	90 feet	Go
12	90 feet	Go

TEST #18

Round #	Distance	Go/No Go
1	50 feet	No Go
2	50 feet	No Go
3	58'9"	No Go
4	58'9"	Go
5	51'10"	No Go
6	51'10"	No Go
7	55'4"	Go
8	55'4"	No Go
9	53'7"	Go
10	53'7"	No Go
11	52'9"	No Go
12	80 feet	No Go
13	80 feet	No Go
14	120 feet	Go
15	120 feet	Go
16	120 feet	Go
17	100 feet	Go
18	90 feet	Go
19	90 feet	Go
20	85 feet	No Go
21	85 feet	Go

TEST #19

GRAZE GAP CONFIGURATION .075", TARGET SHOTS

Round #	Distance	Go/No Go
1	120 feet	Go
2	120 feet	Go
3	120 feet	Go - low order
4	120 feet	Go
5	120 feet	No Go
6	120 feet	Go - low order

TEST #20

LIVE GRAZE TEST **GRAZE TARGET**

Round #	Distance	Go/No Go
1	200 feet	Go
2	200 feet	No Go (go on cage)
3	200 feet	Go
4	200 feet	Go
5	200 feet	No Go
6	200 feet	No Go (go on cage)

TEST #21

GRAZE TESTS, 1cc FLUID REMOVED, GRAZE TARGET

Round #	Distance	Go/No Go
1	200 feet	Go, on cage (missed graze target)
2	200 feet	No Go, hit barrel at 55'
3	200 feet	Go
4	200 feet	No Go
5	200 feet	Go
6	200 feet	Go

TEST #22

FLAT ON BALL BOTTOM

Round #	Distance	Go/No Go
1	200 feet	No Go
2	200 feet	Go
3	200 feet	No Go
4	200 feet	Go
5	200 feet	Go
6	200 feet	Go
7	200 feet	Go
8	200 feet	Go
9	200 feet	Go
10	200 feet	Go
11	200 feet	Go

TEST #23

SPIN WEIGHTS MODIFIED INERT FUZES

Round #	Distance	Go/No Go
1	200 feet	Go
2	200 feet	No Go
3	200 feet	Go
4	200 feet	Go
5	200 feet	No Go
6	200 feet	Go
7	200 feet	No Go
8	200 feet	No Go
9	200 feet	Go
10	200 feet	Go

TEST #24

CENTERING RING HELD ON CENTER

Round #	Distance	Go/No Go
1	200 feet	Go
2	200 feet	Go
3	200 feet	Go
4	200 feet	Go
5	200 feet	Go
6	200 feet	Go
7	200 feet	Go
8	200 feet	Go
9	200 feet	Go
10	200 feet	Go

TEST #25

CENTERED CENTERING RING

Round #	Distance	Go/ No Go
1	90 feet	Go
2	45 feet	No Go
3	60 feet	Go
4	53 feet	Go
5	45 feet	Go
6	53 feet	Go
7	35 feet	No Go
8	45 feet	Go
9	38 feet	No Go
10	45 feet	No Go

TEST #26